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President's Message

by Oscar Robinson - President, Lime Association of Texas



We provide educational workshops, specification review and technical assistance. Our educational workshops cover principals of lime, design considerations and QC/QA presentations. They are suitable for all professionals involved in any aspect of pavement construction from design to inspection.

Dear Colleagues,

The Lime Association of Texas members, Chemical Lime, Texas Lime and Austin White Lime are proud to be part of the growing Texas economy and the association we have with all who are involved in the process.

One of the most unbelievable occurrences any of us could have imagined last year was the double hit Texas and Louisiana took from two devastating hurricanes. The transportation and building construction industries must be alert to what failed and, more important, to what did not fail in the protection and mobility of our citizens.

While Katrina did not hit us as direct as Rita, Texas was the recipient of the evacuating citizens who required infrastructure and housing to continue their lives. Studies are now being finalized on how to plan for smoother evacuation from coastal areas in the future, and we feel certain lime will be a valuable material in the reconstruction of existing infrastructure and the building of new facilities required for orderly evacuation.

The result of the work required to repair hurricane damage combined with a continuously expanding economy in our great state has forced the creation of new engineering and construction firms to help meet these needs.

The Lime Association of Texas wants these firms and owners to know we are a resource for all of their educational needs. We provide educational workshops, specification review and technical assistance. Our educational workshops cover principals of lime, design considerations and QC/QA presentations. They are suitable for all professionals involved in any aspect of pavement construction from design to inspection.

Our emphasis is on the difference between modifying soil and permanently stabilizing it, which is often misunderstood. These workshops can be scheduled to last various time periods to meet your schedule. Larry Peirce, our Executive Director, is ready, willing and able to provide this service free of charge.

Larry provides numerous such informational sessions around the state and, at your request, will be happy to arrange a convenient time, whether you are an experienced tradesman or new to the industry. This same service is continually provided to various city, county and state agencies. A particular benefit of these seminars is the education of what lime is and does and why it is by far the best product for treating high-plasticity clay, which most of our roads and structures are built on.

We look forward to having a long and most satisfactory experience serving all of you in the construction industry, and we sincerely hope you give us a call for your educational workshop. Meantime, come see us at www.limetexas.org.

*Sincerely,
Oscar Robinson, President
Lime Association of Texas*



Looking Back Over 50 Years Focused on the Future

Michael Behrens, P.E. - TxDOT Executive Director

There have been many celebrations this year commemorating the important event of June 29, 1956, when President Dwight Eisenhower signed the epic legislation creating the Interstate Highway System.

Texas was a pioneer in the vast amount of work that got under way building these highways, and today we can boast 3,233 interstate miles, more than any other state.

Around the same time the first interstate projects were getting under way, the lime industry introduced an emerging product in the highway market that proved to be an effective and economical solution for stabilizing highly plastic soils, which many of the new highways were to be built on.

Initially, there were numerous experimental projects done to see how well it would work. Chambers County was a good example of an early test project for field verification. At the time, every-

thing used was hydrated lime, with quicklime being less available and less trusted due to handling concerns.

In fact, in a letter from Dewitt Greer, State Highway Engineer for Texas Highway Department, to the National Lime Association dated Aug. 11, 1958, Greer discussed the growing use of hydrated lime as a stabilization tool in Texas. He said that with increased contractor familiarity and increased production capability the cost should come down, which in turn would stimulate the use of more lime.

Both of Greer's predictions came true, and lime, like the interstate system, can look back over 50 years here in Texas with success.

Looking forward, the accelerated methods to create the infrastructure necessary to handle the massive and inevitable growth in this state over the next 25 years will require well-planned cooperation between TxDOT, the contracting community and the materials industries.

And TxDOT looks to its long-term partners such as the lime industry to handle these challenges as they have over the last 50 years. ■



Around the same time the first interstate projects were getting under way, the lime industry introduced an emerging product in the highway market that proved to be an effective and economical solution for stabilizing highly plastic soils.



Lime Is a Permanent Solution

By Larry Peirce



Stabilized lime layers are engineered to last as long as there will be pavement layers and traffic driving on top of them.

The use of lime for the stabilization of poor soils in the building of roads and highways has been going on for five decades now in Texas. It is interesting to look up one day and realize your product and processes have become such a long member of the road construction industry.

Although the use of lime has seen many advances over this span of time, mainly in equipment changes and the need for faster construction, the product is the same as it has always been. The chemistry that dictates how and why lime reacts with expansive clay remains the same as it was 50 years ago.

It is as important today as it was then to understand what you are trying to accomplish with lime when using it in poor soils.

Lime has three basic uses in roadway construction. The first is as a drying agent for wet soils. Lime is excellent for simply "drying up the mud."

This is not an engineered application. It's a simple process of adding lime to wet soil, mixing a little and making the area accessible to construction equipment.

The second use is modification. Modifying soils with lime has become the most common method for which the product is used. When you modify a soil with lime, you are adding enough lime to create a working plat-

form for the construction of the overlying pavement layers.

What must be realized with modification is it may not give you the permanent chemical changes in the soil that will assure you a foundation that will be in place for the next 50 years.

The third use is stabilization. Stabilized lime layers are engineered to last as long as there will be pavement layers and traffic driving on top of them. Achieving true lime stabilization requires some basic and inexpensive engineering testing and often only a small amount of additional lime over modification.

Twenty years ago this was a much more common practice than it is today. Over the last decade or so, it seems that many of the "old hands" who really understood stabilization have retired. An example is the mass retirement at TxDOT in August of 2003. Well over 600 people with an accumulated 20,000-plus man years of experience retired on the same day.

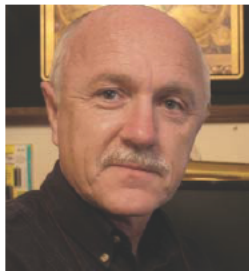
The point is that often we hear people saying "lime stabilization," but what they actually are doing is "lime modification." Both have their place, but one needs to understand the differences between them.

The Lime Association of Texas is an excellent resource for learning more about these different processes. Feel free to contact us at 512-329-8871. ■



Researcher's Perspective on Lime Stabilization

By Tom Scullion, P.E. - Texas Transportation Institute



The Lime Association of Texas asked Tom Scullion to reflect on the lessons learned on the performance of lime-stabilized layers.

Scullion is the manager of the Flexible Pavement Program at the Texas Transportation Institute and has been active in pavement research for over 25 years. He has completed several research studies on stabilizer design and performance and has conducted numerous field investigations on both good and poorly performing pavements in Texas.

IMPORTANT ISSUES ABOUT LIME STABILIZATION

Texas is blessed (or cursed) with some of the most challenging soil conditions in the USA. I am often amused with visits to other states where they discuss the problems of highway construction in clay soil areas.

I recall one DOT design engineer discussing design and performance problems on sections where the soils have a plasticity index of almost 25. Most engineers in east Texas would be happy with that dilemma; they routinely face soils with PI's of 45 and above, which are highly expansive in nature and with seasonal high rainfall and long hot summers to make matters worse.

The use of lime with clay soils has been commonplace in Texas for many decades; in fact the majority of the pavements in East Texas have lime-treated soils, granular bases and thin asphalt surfaces. Many of these pavements are performing well, but in recent years concerns have been raised about the durability or permanency of lime-treated layers.

To address these concerns, it is important to step back and review the current state of the practice, to discuss the laboratory and field tools available

to assist highway engineers design and evaluate treated layers, and to describe how recent findings from research studies can be used to improve the long-term performance of stabilized layers in Texas.

This is a broad area which I have broken it down into five key discussion topics.

WORKING PLATFORM VS. PERMANENT STRUCTURAL LAYER

Discussions with designers around the state on why lime is used often focus on two rationales. First is the working platform concept. In this popular method, also referred to as modification, lime is used to facilitate construction; to provide a weather-resistant platform so that base layers can be adequately compacted.

In this scenario no long-term structural benefits are assigned to the lime layer in the thickness design process. The second concept is for the lime layer to be a permanently stabilized structural layer, which can be counted on for the life of the pavement. This layer helps to distribute the load to the subgrade and provide continuing support to flexible base layers.

With the working platform concept, the lime content is often selected based



on local area experience, and often little or no laboratory testing is conducted.

Frequently lime contents of 3 to 4 percent are used, and experience has shown that these are adequate for soil modification. The permanently stabilized layer concept, on the other hand, requires laboratory testing, which should include a wet/dry strength evaluation. The required lime contents are almost always higher than those used for the working platform.

Overall, I am not a fan of the working platform concept. Soils within each district are different, and assigning a single treatment level without testing can be a problem.

Performance-wise, I believe a lot of the durability concerns are from projects where no design was performed on the project soil. On some projects the lack of uniform long-term support has been found to be a cause of premature pavement roughness and other performance problems.

Lime is no different than any other pavement material. In order for it to perform as intended it must be designed and constructed properly. Without the use of adequate laboratory design criteria it is unfair to complain about perceived poor performance.

LABORATORY PROCEDURES TO DESIGN PERMANENT STRUCTURAL LAYERS Which tests will help ensure that a lime treatment will provide a permanent stabilized structural layer? In my opinion TxDOT already has test method 121-E, which is good for this purpose. For any new project where the durability of the lime layer is a concern, my recommendation is to first run Tex 121-E Part 3, known as the Eades and Grim test.

In this rapid test, a series of pH measurements on soil

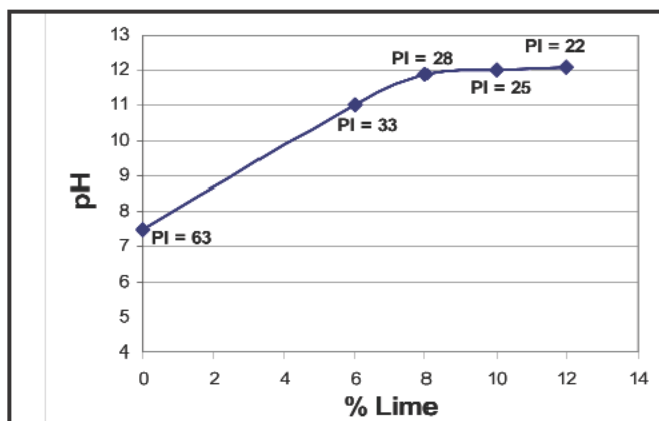


Figure 1 - Problematic soil detected by running the Tx Method 121 Part 3.

treated with varying amounts of lime are run. The level at which a pH value of 12.4 is attained is assumed to be adequate to satisfy both the short-term reactions and sustain long-term pozzolanic strength gain.

The limitation of this test is that this simple pH test will not guarantee that sufficient strength gain or moisture resistance will be achieved. However, in my opinion the test is still valid as a tool for identifying soils that do not readily react with lime.

This is shown in Figure 1, which illustrates results from a soil from Bryan, Texas. This soil did not respond to the addition of up to 12 percent lime, the pH never reached the target value of 12.4 and the PI never dropped below a value of 22.

Normally the pH and PI reduction requirement for most Texas soils are met with lime contents between 3 and 8 percent. However this is not the case with the soil shown in Figure 1. These results are not common but they are typical of soils with a high organic content. If results such as these are obtained then additional test must be run before proceeding to construction.

The critical final step in any mix design procedure is to perform a wet strength evaluation at the proposed lime content. This is part 1 of Tx-Method 121 E. After curing for seven days the sample is subjected to 10 days capillary rise and then strength testing. The recommended acceptable strength level is 50 psi for soils and 100 psi for bases.

Running the part 3 test to identify problematic soils and then part 1 moisture conditioned strength testing is highly recommended. Stabilizer contents selected using these procedures will have a high probability of success. The problem with the strength testing is time - to run the full part 1 sequence tasks at least three weeks.

TxDOT's current research program has initiated a project to accelerate this process with the stated goal of performing wet/dry strength testing in less than one week. An accelerated test procedure is urgently needed.

EVALUATING LIME LAYERS IN THE FIELD Texas has two field tools that have been widely used to determine if a lime-treated soil or subbase layer is performing as designed.

The first is the Falling Weight Deflectometer, which measures the in-situ strength of the entire pavement structure. Stiff lower layers will provide a characteristic flat deflection bowl with small changes in deflection in the outer sensors.

The most useful tool is the Dynamic Cone Penetrometer shown in Figure 2. This device is widely available in Texas.



Figure 2 - Dynamic Cone Penetrometer testing.

A small (1 in. diameter) access hole is drilled through surface layers and heavily stabilized base layers, and readings are initiated in the untreated base or subbase layers.

The cone on the DCP is driven through the lower layers using an 18-lb. weight dropped from a standard height of 39 in. The rate of penetration is an indication of the strength of the pavement layers.

The DCP can also be used to measure the effective thickness of any treated layer. As soon as the tip enters the weaker untreated soil a large increase in penetration rate will be observed.

Penetration rates in lower pavement layers can range from 0.1 in. (and less) per blow to more than 5 in. per blow in very weak areas.

The benefit of the DCP is that it can rapidly estimate both the strength and the thickness of any treated layers. The U.S. Army Corps of Engineers is a big proponent of this test and now conducts it to determine the in-place California Bearing Ratio (CBR) for pavement design procedures.

Based on the corps' equations Table 1 provides guidelines on interpreting DCP data.

Frequently with stabilized base materi-

als it is impossible to get meaningful DCP data because the material is too stiff. However, with lime-stabilized soils it is usual to anticipate values of between that of a good soil and a lower-quality granular base. Penetration rates of a maximum of 0.5 in. per blow would be anticipated for lime-treated soils.

Numerous DCP tests have been conducted on lime-treated soils in Texas. Substantial data from four Texas districts was presented in TTI Report 1287-2 (Little, et al., 1995).

The results from all of the sections in the Fort Worth District were particularly interesting. In three of the sections, the lime-treated subgrade layer was over 15 years old. The DCP results from one section on U.S. 287 are shown in Figure 3. In this particular case the subgrade layer was treated to a depth of 14 inches with 6 percent lime.

The data from this section show that the lime layer was performing as anticipated and was extremely stiff providing excellent support to the pavement layers. The computed CBR values were

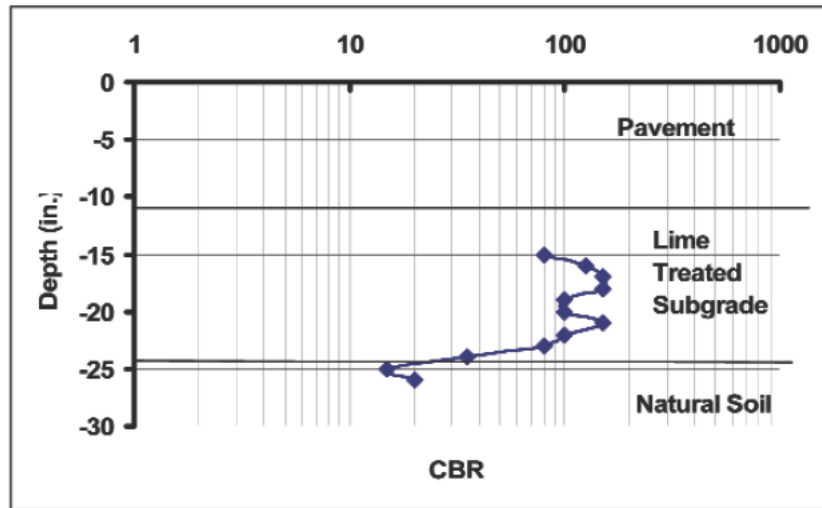


Figure 3 - DCP data from US 287 Fort Worth

Penetration Rate (ins/blow)	CBR (approx)	Description
0.1	100	Top class granular base
0.2	50	Granular base
0.75	10	Very good subgrade soil
1.5	5	Weak soil
3.5	2	Very weak soil

Table 1 - Typical schemes used to interpret DCP data



100+, indicating that the penetration rate through the lime-treated soil was less than 0.1 in. per blow.

In addition, after 15 years in service, the treated layer thickness was found to be close to the as-designed thickness of 14 in.

DISTRICT EXPERIENCES Several Texas districts have decades of positive experience with lime stabilized layers. One example is the Fort Worth District. Starting in the 1960s, several sections were designed and closely monitored to develop a districtwide policy for lime stabilization.

For each new project a detailed soil survey is performed where boring are taken typically at 0.5 mi. intervals. A full range of geotechnical tests are conducted on soil samples obtained. With regard to lime stabilization, the following general notes were adopted based on earlier experience.

- 1) Treat all soils with PI > 20 with 6 percent lime (for soils between 15 and 20 the need for lime stabilization is judged on a case by case basis)
- 2) For soils with PI's between 20 and 39 stabilize to a depth of 8 in.
- 3) For soils with PI's above 39 stabilize to a depth of 18 in.



Figure 4 - Lime treated subgrade from SH 114 Fort Worth.

4) For Fill material > 18 in. thick and a PI > 39 treat 18 in.

5) For Fill material < 18 in. with PI > 30 treat 18 in.

6) In Cut sections material PI > 30 treat 18 in.

Using this policy, the district lab engineer, Richard Williammee, has not reported any permanency problems with the district's lime treated subgrades.

An example of a very stiff lime treated subgrade layer is shown in Figure 4. This was recently cored from a 2-year-old, full depth asphalt section on SH 114 in Wise County.

The soil in this area was a combination of silty clay with near-surface bedrock. Clearly this layer reacted well with lime and the bond between the lime layer and asphalt treated base was excellent.

CHALLENGES The performance problems reported with lime-stabilized soils have been under review in studies completed by the Texas Transportation Institute.

New tests have been developed to detect problematic levels of sulfates in Texas soils. These test are Tx Method 145 E (Colorimetric Method) and 146 E (Conductivity Method). Each Texas district is now routinely checking soils for high risk levels of sulfates (values greater than 8000 parts per million).

Work underway at TTI is also looking for alternatives for lime in these high risk areas. From work completed by Dr Pat Harris it appears that combinations of lime and ground-granulated blast furnace slag, or lime and fly ash, can be used to provide adequate strength and mitigate swell problems.

Under the direction of Caroline Herrera, PE, head of the soils and aggregates section of TxDOT's Construction

Division, new guidelines on stabilization have recently been developed. These provide logical procedures for selecting the optimal stabilizer content for any soil. Training schools to implement these guidelines are being planned.

Lime treatment of Texas soils to provide a foundation layer for Texas pavements remains a cost effective option. TxDOT already has good laboratory testing procedures and construction specifications to ensure that the lime stabilized layer will perform as designed.

In the past 10 years TxDOT has made large strides to implement policies with regard to providing long-term smooth pavements for the traveling public. Contractors are frequently given bonuses and penalties for the smoothness of their original construction. The implication here is that smooth pavements will remain smooth.

This is often not the case. In studies I have completed, I would think the majority of the roughness problems I have seen are more often associated with the quality and design of the pavement foundation layer. In addition to rewarding initial smoothness, I think greater gains could be made by rewarding uniformity of subgrade support.

I recall many years ago talking to an old German pavement designer. He said that in Germany no formal designs are performed on the upper pavement layers. They are all listed in catalogues based on soil type, traffic level and environmental zone.

Where German designers spend their time is in designing the foundation layers. Detailed lab work is performed on the in-situ materials and acceptance of the lower layers is usually based on deflection testing often with instrumented rollers. The older I get the more these recommendations make sense. ■



The Role of Hydrated Lime in Hot Mix Asphalt

By Dale Rand, P.E. - TxDOT Flexible Pavements Branch Director

Lime plays a significant role in the performance of many hot-mix asphalt pavements. Lime has traditionally been used to improve the performance of HMA by providing protection from moisture damage, which is commonly known as stripping. Lime also provides stability to HMA mixtures, which in turn reduces the risk of rutting.

Many experts believe that stripping occurs due to a chemical incompatibility that causes a lack of adhesion between the asphalt and aggregate. The phenomenon of stripping has been cited as the cause of numerous premature failures in hot mix.

Most of the premature failures that have occurred in Texas were in the northeastern and southern parts of the state where the use of siliceous gravel is common. Harder aggregates such as siliceous gravel, granite and sandstone aggregates tend to be more prone to stripping compared to softer aggregates such as limestone.

Hydrated lime has been shown to be highly effective at reducing stripping in harder aggregates.

The Texas Transportation Institute issued a research report in 2002 titled "A Follow-Up Evaluation of Hot-Mix Pavement Performance in Northeast Texas." The report concluded that hydrated lime used as an anti-stripping agent has a positive influence on the performance of mixtures containing crushed siliceous river gravel. This conclusion was based on the long-term performance of 35 pavements located in the Atlanta, Lufkin and Tyler districts.

Pavement evaluations and laboratory analysis including the Hamburg Wheel test showed that the mixtures treated with hydrated lime clearly outperformed the mixtures that did not contain hydrated lime. Forensic studies on premature pavement failures in South Texas also concluded that hydrated lime should be used with mixtures containing siliceous aggregates.

In addition to providing resistance to moisture damage, hydrated lime often acts as mineral filler that provides increased stability to HMA. Premium HMA mixtures such as SMA and PFC rely on the hydrated lime to provide a stiffening effect to the binder. This is often needed in these types of mixes due to the tender nature of the mixes that have relatively high film thicknesses of asphalt.

In terms of rutting resistance, the Hamburg Wheel test has shown that the addition of 1 percent hydrated lime has a similar effect of increasing the PG binder by 1 grade. In other words, a mix with PG 64-22 and 1 percent hydrated lime will provide approximately the same rutting performance as a mixture with PG 70-22 without the hydrated lime.

This is not to say that hydrated lime should be used indiscriminately in lieu of selecting the appropriate PG binder grade for a given application. The addition of hydrated lime can clearly provide an increase in rutting resistance, but higher binder grades such as PG 70-22 and PG 76-22 typically utilize elastomeric polymers to achieve both an increase in rutting resist-

ance as well as cracking resistance. It may be appropriate to use hydrated lime in lieu of increasing the PG binder grade in cases where the primary concern is rutting resistance, and cracking resistance is not much of a concern.

A good example would be an intersection on a low- to moderate-volume roadway that would typically have HMA on a pavement with PG 64-22 as the binder. In such cases, rutting can often be observed in the intersection area, whereas cracking is seldom a major issue. The addition of hydrated lime to the mix in the intersection may be much more cost-effective than increasing the binder grade to PG 70-22.

In summary, the benefits of hydrated lime in HMA range from providing resistance to moisture damage to functioning as a mineral filler and providing stability to hot-mix asphalt mixtures with high binder film thicknesses such as PFC and SMA.

The Hamburg Wheel test has proven to be a successful tool for evaluating paving materials to predict whether hydrated lime or any other additive can provide improved performance to HMA. Research, testing and pavement evaluations conducted by TxDOT clearly show that hydrated lime, when properly used in HMA, can significantly extend the performance life of flexible pavements. ■





A 33-year Career in the Lime Industry

Profile of Bill Hughes - Texas Lime Company

If it has something to do with lime, Bill Hughes has probably seen it.

The days of people spending 33 years (and counting) in the same industry is becoming a rarity. Obviously, Bill found something he liked. The lime industry is funny that way. So many people that got bit by the lime bug early and never could get it out of their system.

Bill was born and grew up in Batesville, Ark. He graduated from Batesville High School and Arkansas State University in Jonesboro. He married his high school sweetheart, Sandra Nash, and they have one son, William Boyce, who is a senior vice president, financial adviser with Morgan Keegan in Tennessee.

They also have a 13-year-old grandson.

"We particularly enjoy all activities with family," Bill said. "We've traveled extensively over the years and expect to do much more. My major vice is golf, which is also my major frustration."

Bill stays busy being active in his church and currently teaches a Sunday school class. He is a member of the Regional Advisory Board of Lyon College and is a past Rotarian. He maintains a residence in Dallas near the home office as well as a home in Batesville.

Bill did not have to look far to get into the lime business. In 1973 he was hired as a salesman at Arkansas Lime Co. in Batesville by longtime industry leader J.T. "Mac" McKinnon.

Arkansas Lime was a sister company to Texas Lime Co. Both were wholly owned subsidiaries of Rangaire Corp. Bill became vice president of sales and marketing for both companies in 1983 and now serves as senior VP-sales and marketing for U.S. Lime and Minerals, which operates plants in Oklahoma and Colorado in addition to Texas and Arkansas. He also oversees a terminal and hydrator in Shreveport and a slurry operation in Houston.

Bill is currently a board member for the Lime Association of Texas and provides excellent guidance to the Texas activities. He has also been active with the National Lime Association for more than 20 years and currently is chairman of the NLA Promotion Committee.

This important committee develops the ideas for the promotional and research activities for the lime industry on a national level. Currently, major initiatives are under way in both lime for soil stabilization and hydrated lime in hot-mix asphalt. There also are environmental initiatives.

Bill has personally seen the benefits of the long-term research efforts that have paid off in increased lime usage through technology transfer.

"The lime industry has changed tremendously over the 33 years I have been in," he said. "There used to be many more companies (mostly family owned), but consolidation of the indus-

try has created fewer companies that are much larger. The result of this is that the five largest lime companies now supply about two-thirds of the lime in the U.S."

Although the steel industry is still the largest user of lime, the environmental uses (particularly power plant stack scrubbing) have now grown to a close second.

"I am most gratified to know that the construction uses (both stabilization and lime in asphalt) have grown significantly over the past two or three decades," Bill said. "I am further gratified that I have been privileged to be a small part of that growth."

Some of the major changes Bill has seen in the lime industry have been the switch from natural-gas-fired kilns to the blend of coal and petroleum coke now used. Many plants have closed due to outdated technology while new plants have been built that are more efficient. Other existing plants have added more capacity.

The research continues about the technology of lime production and will doubtlessly bring more changes.

"The future looks bright for the lime industry as lime is so very friendly for the environment. Use of lime for treatment of potable water, waste water and





LIME ASSOCIATION OF TEXAS

The Many Uses of LIME: The Versatile Chemical

SUBGRADE SOILS

- ★ Dries Wet Soils
- ★ Reduces Plasticity
- ★ Improves Stability
- ★ Provides Solid Platform
- ★ Efficient, Permanent Strength Gain

BASE MATERIALS

- ★ Enhances Poor Material
- ★ Increases Strength Without Causing Cracking
- ★ Economic Recycling of In Place Roadways

HOT MIXED ASPHALT

- ★ Combats Moisture
- ★ Eliminates Stripping
- ★ Reduces Rutting
- ★ Reduces Premature Aging

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